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THE REPRODUCTIVE POTENTIAL OF *ERICA JUNONIA* BOLUS: MEGASPOROGENESIS AND MEGAGAMETOGENESIS

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Abstract

The embryological study of *Erica junonia* forms part of an investigation into the inadequate propagation of the species. The ovule is anatropous, unitegmic and tenuinucellate. The archesporial cell functions directly as the megaspore mother cell. Embryo-sac development is monosporic and conforms to the Polygonum-type of the Supra Homotypic Category. Starch grains are present in the integument and an endothelium lines the chalazal region. Observations thus far suggest no restrictive effect on the reproduction of *E. junonia.*

Uittreksel

DIE VOORTPLANTINGSPOTENSIAAL VAN *ERICA JUNONIA* BOLUS: MEGASPOROGENESE EN MEGAGAMETOGENESE

Die embriologiese studie van *Erica junonia* maak 'n deel uit van 'n ondersoek na die gebrekkige voortplanting van die spesies. Die saadknop is anatroop, tenuinusellêr en besit 'n enkele integument. Die argesporiale sel funksioneer direk as die megaspoormoedersel. Embriosakontwikkeling is monospories en geskied volgens die Polygonum tipe van die Supra-Homotipiese Kategorie. Styselkorrels is teenwoordig in die selle van die integument en die chalazagedeelte van die embriosak word deur 'n endotelium omhul. Hierdie studie van megasporogenese en megagametogenese toon geen beperkings op die voortplanting van *E. junonia.*

Introduction

The large-flowered variety of *Erica junonia*, reputed to be the most magnificent of the ericas, occurs only on a single mountain peak in the Cold Bokkeveld north of Ceres (Baker & Oliver, 1967). It flowers from November to January. Germination of seeds has been unsuccessful, but the species can be propagated by means of cuttings. However, these vegetatively propagated plants do not set seed.

The inadequate propagation of *E. junonia* led to its being declared an endangered species by the C.S.I.R.'s Working Group on Rare and Endangered plant species. This study forms part of an attempt to pinpoint the locus which blocks the pathway to successful propagation.

Material and Methods

Flowers of *E. junonia* were collected from their natural habitat near Ceres and fixed in formalin-acetic acid-alcohol. Dehydration was carried out in an ethyl alcohol/tertiary butyl alcohol series and the material was embedded in Carowax

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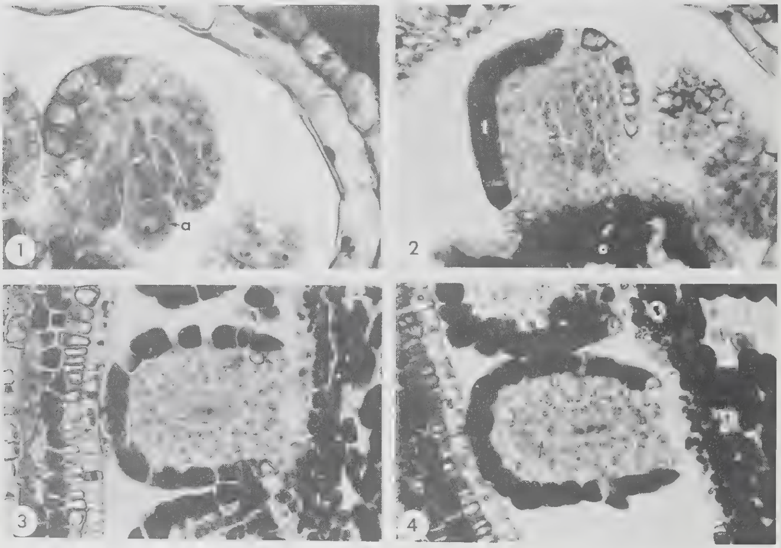
(melting point 55 °C). Ovaries were sectioned on a rotary microtome at 10 μm and stained with safranin and fast green (Sass, 1958).

RESULTS AND DISCUSSION

Megasporogenesis

Numerous ovules are contained in each of the four locules. Their placentation is axile. Each ovule is anatropous (Fig. 2) and has a single, large integument (Figs 1 & 2). According to Davis (1966) these characteristics are reasonably constant for the Ericaceae. When the embryo sac reaches maturity the epidermis of the integument becomes completely tanniniferous.



Megasporogensis in *E. junonia*

FIG. 1
Young ovule showing archesporial cell
(a = archesporial cell, i = integument) (×600)

FIG. 2
Megaspore mother cell. Note the absence of nucellus
(i = integument, mc = megaspore mother cell, t = tanniniferous cells) (×380)

FIG. 3
Heterotypic division of meiosis (×380)

FIG. 4
Tetrad of megaspores in which three micropylar ones are degenerating
(functional megaspore arrowed) (×380)

At a very early stage in ovule development a single hypodermal cell becomes prominent. This is the archesporial cell (Fig. 1) and it functions directly as the megaspore mother cell. There are no parietal layers between the nucellar epidermis and the megaspore mother cell and so the ovule can be classified as tenuinucellate. According to Maheshwari (1950) there are two types of tenuinucellate ovules, namely, those in which the integument primordia are situated near the apex of the nucellus and a second type in which the integument originates at the base of the nucellus. In *E. junonia* the latter type occurs.

The nucellus is only three cell layers wide and is ephemeral. Its degeneration occurs rapidly during the development of the megaspore mother cell. This cell enlarges (Fig. 2) at the expense of the nucellus so that at maturity it is bordered completely by the integument only.

Fig. 3 shows the metaphase stage of the heterotypic division during meiosis of the megaspore mother cell. After completion of the homotypic division, a linear tetrad of megaspores is formed (Fig. 4).

Megagametogenesis

Of these four megaspores only the chalazal one persists (Fig. 5) and functions as the embryo-sac initial. The development of the embryo-sac is therefore monosporic. The nucleus of the functional megaspore is centrally situated and until this stage the embryo-sac exhibits no polarity.

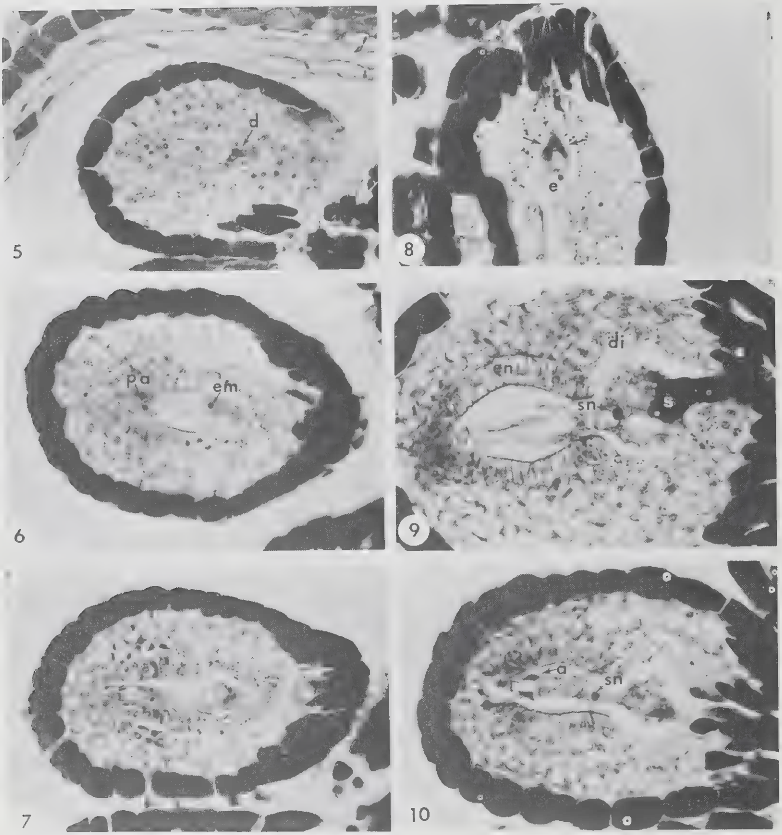
Division of this nucleus results in the formation of a two-nucleate embryo-sac (Fig. 6). One of these nuclei, the egg-apparatus mother nucleus, migrates towards the micropyle while the other nucleus, the primary antipodal nucleus, moves to the chalazal end. Because polarity of the embryo-sac is established at this stage of development, the embryo-sac of *E. junonia* conforms to the Supra Homotypic Category (Swamy & Krishnamurthy, 1975).

Once polarity has been achieved, the embryo-sac enters the elaboration phase. Each of the two nuclei divides, producing a four-nucleate embryo-sac (Fig. 7) and following yet another division, the embryo-sac contains eight nuclei.

These eight nuclei now undergo organization into the constituents of a mature embryo-sac. At the micropylar end the tripartite egg apparatus consists of an egg cell flanked by two synergids which soon become densely cytoplasmic (Fig. 8). The micropylar region of the embryo-sac becomes spherical and enlarges at the expense of the integumentary tissue, the cells of which contain numerous starch grains. Davis (1966) reports the occurrence of starch grains in the embryo-sacs of many ericaceous species.

A well-differentiated endothelium lines the chalazal region of the embryo-sac (Figs 9 & 10)—the function of this endothelium is not clear. Opposite the point where the endothelium layer terminates the secondary embryo-sac nucleus occurs (Fig. 9).

Three antipodal cells are found in the chalazal region of the embryo-sac. Each



Megagametogenesis in *E. junonia*

FIG. 5
Uni-nucleate embryo-sac (d = degenerating megaspores) (×380)

FIG. 6
Two-nucleate embryo-sac
(em = egg apparatus mother cell, pa = primary antipodal nucleus) (×380)

FIG. 7
Elaboration phase showing four-nucleate embryo-sac (×380)

FIG. 8
Egg apparatus (e = egg cell, synergids arrowed) (×380)

FIG. 9
Mature embryo-sac
(di = degenerating integument cells, containing starch grains, en = endothelium, s = synergid, sn = secondary embryo-sac nucleus) (×380)

FIG. 10
Mature embryo-sac (a = antipodal cells, sn = secondary embryo-sac nucleus) (×380)

cell has a definite cell wall (Fig. 10). The antipodals are derived from a single primary antipodal nucleus and therefore the embryo-sac of *E. junonia* is of the Polygonum type (Swamy & Krishnamurthy, 1975).

This study shows that the processes involved in the attainment of haploidy, the establishment of polarity and the maturation of the embryo-sac appear to take place normally. Up to this stage, therefore, there is no restriction on the propagation potential of *E. junonia.*

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